



Climbing into the crown directly 1 **the advanced line technique for gaining access to tree crowns**

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Publication date:
1994

Document version
Publisher's PDF, also known as Version of record

Citation for published version (APA):
Robbins, A. M. J. (1994). *Climbing into the crown directly 1: the advanced line technique for gaining access to tree crowns*. Danida Forest Seed Centre. Technical note Vol. 7



TECHNICAL NOTE NO. 7

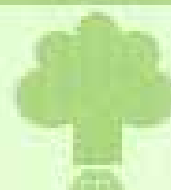
November 1983
(Re-issued November 1994)

CLIMBING INTO THE CROWN DIRECTLY 1.

The advanced line technique for gaining access to tree crowns

compiled by

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Titel

Climbing into the crown directly

1. The Advanced Line Technique for Gaining Access to Tree Crowns

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Publisher

Danida Forest Seed Centre

Series - title and no.

Technical Note no. 7

ISSN:

0902-3224

DTP

Melita Jørgensen

Citation

Robbins, A.M.J., 1983. Climbing into the crown directly. 1. The Advanced Line Technique for Gaining Access to Tree Crowns. Technical Note no.7, Danida Forest Seed Centre, Denmark

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1. INTRODUCTION

A worker normally gains access to the crown of a tree by climbing the bole using spurs, ladders or tree bicycle and then moving around the crown aided by the branches and a safety belt and rope. Alternatively access may be gained independently of the tree, such as by scaffold tower, free standing ladder, hydraulic platforms, or even helicopter. In some cases it may be possible for the worker to operate from the ground using equipment such as a long handled cutter, rifle or tree shaker.

However, some trees have characteristics that preclude the use of these methods. This is typical of many tropical hardwoods, being very tall with a smooth bark, and/or having crowns with few, large and spreading branches. One method of access to such trees that is practical, versatile and safe, is based on the technique of shooting a light nylon line into the crown of the tree, as described by Strickland and Peters (1961). It can be called the 'Advanced Line' technique (Anon, 1979). The line is used to position a thicker intermediate cord, and finally a working rope which can be used in several ways (see Fig. 1): The rope can be used by the worker from the ground simply to shake branches and dislodge fruits, or for cutting branches by means of a flexible saw (Boden, 1972) or by special cutter (Collis and Harris, 1973).

Alternatively, the worker can get near or into the crown using the rope to position a rope ladder or block and tackle. The rope may also be used for guying the tree prior to felling, or for use as an anchor in cable logging systems.

The technique is practical only if the worker has a simple and accurate method of placing the advanced line over the branch required. This is done by attaching a projectile to the end of the line and then throwing this by hand, if the branch is not too high and aim is not critical (Doran et al. 1983), or by using some form of throwing aid. Gysel (1960) describes the use of a standard bow (40 lbs) and arrow for this purpose, whereas the U.K. Forestry Commission uses a more powerful crossbow and bolt (Anon 1979). Collis and Harris (1973) describe a method using a machined rod fired from the barrel of a .45 calibre rifle, or using a missile which is placed over the muzzle of a .22 calibre pistol. In Denmark, a compressed air rifle has been developed which fires large projectiles in the form of a cigar tube (Barner, 1983). There are also several line throwing devices used for rescue operations and marking trees with flags.

These methods have disadvantages: the projectiles tend to be long and lodge in the crown if there are many branches and leaves; since they are generally difficult or expensive to make, it is inconvenient to replace the projectiles when lost, as frequently happens; and the use of firearms may be dangerous or inadvisable in certain countries or work situations. Probably the best system is that which uses a compact lead weight as a projectile, shot by catapult, such as described by Strickland and Peters (1961); but with standard hand catapults, power and accuracy are not good. A more sophisticated catapult, which can be cocked and fired by means of a trigger mechanism and aimed using sights has been developed in Honduras (Robbins et al. 1981).

An indispensable part of the equipment is a method of storing and unreeling the light nylon line with a minimum of resistance to the projectile. This is done using a drum or fishing reel which permits uncoiling of the line over one face, and which can be attached to the catapult or bow (Gysel, 1960; Robbins et al. 1981; Barner, 1983) or held separately by an assistant (Anon, 1979; Collis and Harris, 1973). Many of the commercial line-throwing devices have the line prepacked within the projective itself. The simplest and most reliable of these methods is probably the drum storage as used by Robbins et al.

As will be realised from the above, there are many methods of employing the advanced line technique devised by independent workers. There is no ready-made system suitable for forestry that can be purchased, and it is up to the forester to make his own. The system developed in Honduras by the author has been used successfully and is thought to be a good basis for further development. It is described in more detail in the following paragraphs to emphasize general principles and constraints of the technique.

2. THE HONDURAN SYSTEM

This system was developed at the Escuela Nacional de Ciencias Forestales (ESNACIFOR) in Honduras for seed collection from broadleaf trees. The catapult used was designed to be simple to make from local materials, capable of operating under high-forest conditions, and sufficiently accurate and powerful to cope with tall broadleaf trees, having a height range of at least 30 m, and an accuracy of ± 1.5 m at full height.

2.1. Basic design constraints

There are two main constraints that apply to any projection device developed for the advanced line technique:

Projectile. The projectile must have a certain minimum weight that will allow it to pull the line over the branches, overcoming surface friction of the bark, and also the weight of and wind drag on the line between branches and catapult. Certain trees may have bark types and/or numerous twigs which produce so much friction that heavier projectiles must be used. The Honduran catapult uses a minimum weight of 80g, which can be increased up to 130g. The maximum weight usable is determined by the height range required and the power needed to achieve this. Collis and Harris (1973) used projectile weights up to 300g. The shape of the projectile must be suitable for firing, capable of penetrating foliage with a minimum of resistance, and should minimise snagging if the projectile has to be pulled back over branches for repositioning. The Honduran catapult uses a compact cylindrical lead weight with a conical end, cast from a simple mould.

Line. The line has to be sufficiently strong to resist the drag and weight of the intermediate cord when this is pulled back over the branches, and also the forces resulting from checking the projectile if a line brake is used, or when pulling the projectile free of minor snags. The line must be as light and as slippery as possible to minimise the weight of the projectile required to overcome line weight and frictional forces. The storage drum must allow the line to pay off with the minimum of resistance, as this will cause the greatest drag during firing. Both drum and line can be lubricated with water to reduce friction (Collis and Harris, 1973). The Honduran catapult uses nylon monofilament fishing line, diam. 0.7 mm, with a breaking strength of 18 kg, stored on a parallel sided drum.

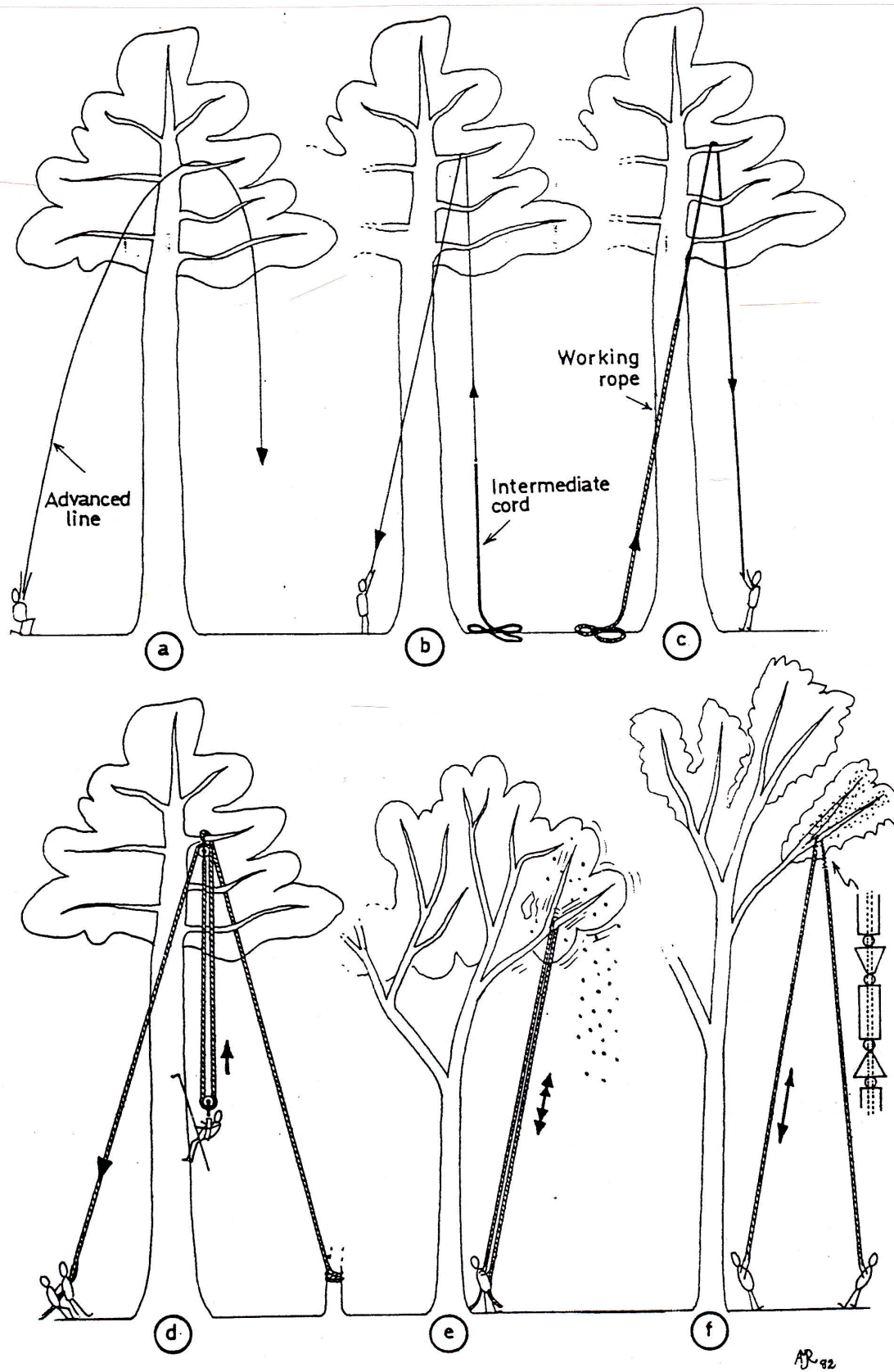


Figure 1

2.2. Catapult construction

The Honduran catapult comprises:

- (i) body
- (ii) propulsion unit
- (iii) tensioning device
- (iv) firing mechanism
- (v) projectile and line system, and
- (vi) sights

See figure 2 for general layout.

Body. This consists of two wooden spars (r) joined together by plywood pieces, to which are fixed two handles (l, j) and all the other parts.

Propulsion unit. The motive power is provided by two doubled lengths of surgical latex tube (b), fixed to the spars by anchor bolts (a), and joined together at the opposite ends by a wire connecting piece (e) which serves for attachment of a leather projectile pouch (d), acts as a hook for engaging the trigger catch (q), and provides a fixing point for a tensioning/restraining cord (f). Total force provided by the latex tubes when fully stretched is from 20 - 28 kg, dependent on the anchor bolt position. Care must be taken to obtain rubber of the correct stress/strain characteristics.

Tensioning device. The propulsion unit is stretched and engaged with the firing catch by means of a cord (f) provided with a handle (v) and attached to the extreme end of the wire connecting piece. The cord is led around a pulley (u) so that the handle may be pulled vertically upwards whilst the catapult is pinned to the ground by means of the footplate (k). After tensioning, the cord is retracted by means of a length of elastic (t). The cord also restrains the propulsion unit after firing, ensuring that it does not entangle in the line or drum.

Firing mechanism. This consists of two parts (q): a catch which engages the wire connecting piece, and a trigger which releases the catch.

Projectile and line system. The projectile (w) is a lead weight, as described above. It is attached to the line by means of a loop and wire eye. When the projectile is loaded, the line between the storage drum and projectile is threaded down a split rubber tube guide (c) which ensures that during firing, the line cannot loop and catch on any projection. A projectile holder (g) at the rear of the tube guide enables the line to be threaded before the propulsion unit is tensioned. To load, the projectile is simply passed from holder to leather pouch.

The storage drum (p) is cylindrical, removable, and it can rotate. When the catapult is fired, the line is pulled free from the rubber tube guide, and then pays off the front face of the drum, which remains stationary. The drum is removed from the catapult to rewind the line onto it. The drum can rotate so that slack in the line can be adjusted when loading. The line may be braked to slow and stop the flight of the projectile by means of a simple trigger lever (n) which presses against the front edge of the storage drum. A plywood disc (m) prevents loose line coils from falling off the back of the drum.

Sights. These consist of a rear sight (h) formed by a small hole in the face protector, which can be adjusted laterally to compensate for bias, and a T-shaped front sight (s) set between the spars, giving a fixed vertical angle of sight. The required aiming angle is estimated from these two sights.

ESNACIFOR CATAPULT / Ballesta

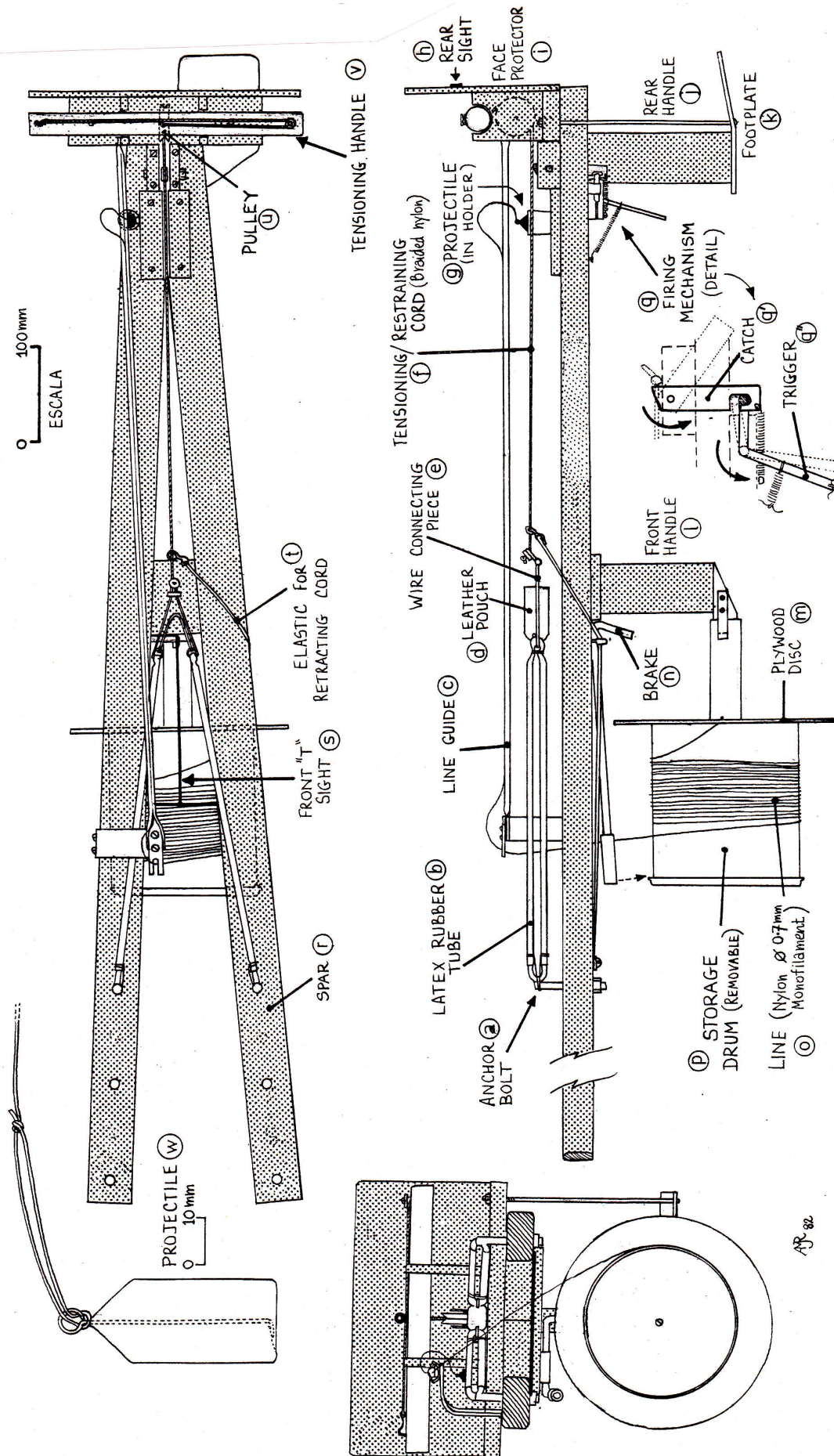


Figure 2

3. OPERATING THE CATAPULT AND LINE POSITIONING

General procedure. The catapult is tensioned and loaded while placed on the ground, then raised to eye level, sighted and fired. Once the projectile has passed the selected branch(es), it is braked, if required, to avoid passing further branches, and allowed to fall to the ground (Fig. 1a). The projectile is then recovered and removed from the line, and a cord (4 mm diam. nylon, 70 kg breaking strength) is attached in its place. This is then hauled over the branch(es) using the line which is rewound onto the drum (Fig. 1b). When the cord has returned to the operator, the line is detached, the projectile replaced on it, and the drum returned to the catapult. The cord is then attached to a working rope (13 mm diam. nylon) which is in its turn hauled over the branch(es) and used for the technique required and described in detail later (Fig. 1 c,d,e,f).

Aiming. The angle of aim has to compromise ease of sighting with height range. Low angles facilitate sighting but reduce height range, whereas an increased angle makes vertical accuracy more difficult. In tropical high forest sighting can only be done close to the tree and is often difficult due to the presence of foliage. The best practical angle is between 60-75° to the horizontal.

Misfires and projectile retrieval. It is inevitable that many shots will be badly placed and require repeating or adjustment. If the projectile passes over the wrong branch, it can be retrieved by pulling it back over the branch until it falls free. If the projectile catches in the V of two branches, so that it cannot be pulled back, it should be allowed to fall, pulling the line with it, after which the projectile can be removed and the line pulled free without it. If the projectile passes too many branches, it can be pulled back until the line passes only over the desired branches, but care must be taken not to let the projectile swing excessively, which may cause the line to wrap around a branch or on itself and thus become entangled. Should this happen, the only solution is to jerk and break the line which normally snaps next to the projectile allowing it to drop free.

Safety during shooting. Like any device originally conceived as a weapon, a catapult can be dangerous, so suitable precautions must be taken. The operator and assistant should wear safety hats at all times, and no one should be in front of the line of fire. The projectile can rebound towards the operator either if the line snags on the catapult or if it ricochets from the stem or branch, or if it is suddenly pulled free from a branch snag while being retrieved after a misplaced shot.

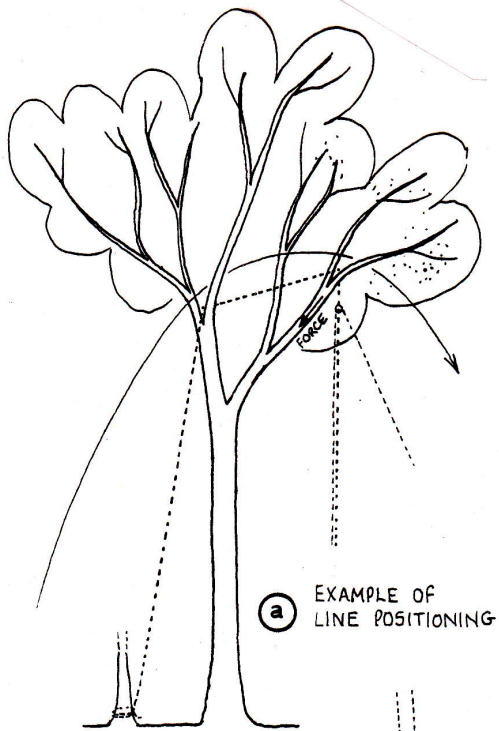
4. USE OF THE WORKING ROPE

For seed collection, the working rope can be used in three principal ways, which require different positioning of the line in the crown:

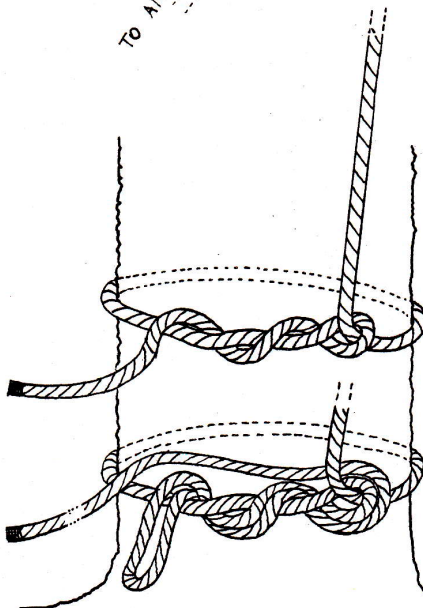
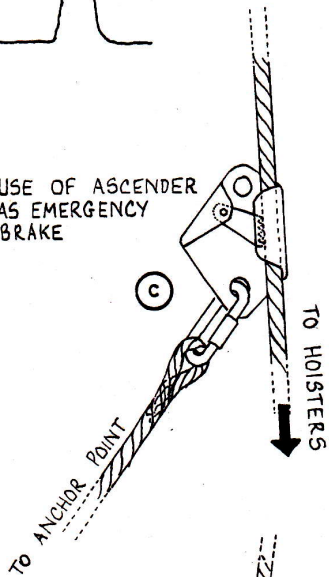
Shaking branches. Several species have fruits which can be dislodged simply by shaking the branches (e.g. *Cedrela*). In this case the line should be placed over branches at about half to three-quarters their length from the bole. This will allow the maximum flexing or whipping of the branch when jerked from the ground. Some experience will be required to get the right sort of movement to break the peduncles of the fruits. Positioning of the rope is not very critical for this technique, and it does not matter if the line passes over several branches.

Cutting branches. Fruits of some species (e.g. *Eucalyptus*) can be harvested by cutting complete branches with a flexible saw (BoLand et al. 1980; Boden, 1972). These saws are described in Technical Note no.13 (Robbins 1984). In this case, care must be taken in placing the line, which must pass only over the branch to be cut, generally next to the bole or junction with another branch. The angle of pull on the saw is important and it can be difficult to achieve the optimum because of the position of other branches. Collis and Harris (1973) describe a cutter that is designed to cut the ends of branches and then hold them so that they can be pulled back to the operator. In this case, the line must be positioned carefully over the end of the branch it is desired to cut.

Gaining access to the crown. The most important use of the working rope is to allow the worker access to the tree crown. There are many ways of doing this: the rope may be climbed directly with the help of mountaineering ascenders; a rope ladder can be positioned; or a block and tackle (system of pulleys and ropes) can be used with which to hoist the worker into the crown (Fig. 3). This latter method is probably the best, as it is safest and the worker arrives in the crown free of fatigue. Details are given in the following paragraphs.



USE OF ASCENDER AS EMERGENCY BRAKE



TIMBER HITCH
FOR USE WITH WORKING ROPE
AND/OR HOISTING ROPE

(d)

ALTERNATIVE FORM
USED WHEN THE ROPE
HAS A LONG FREE END

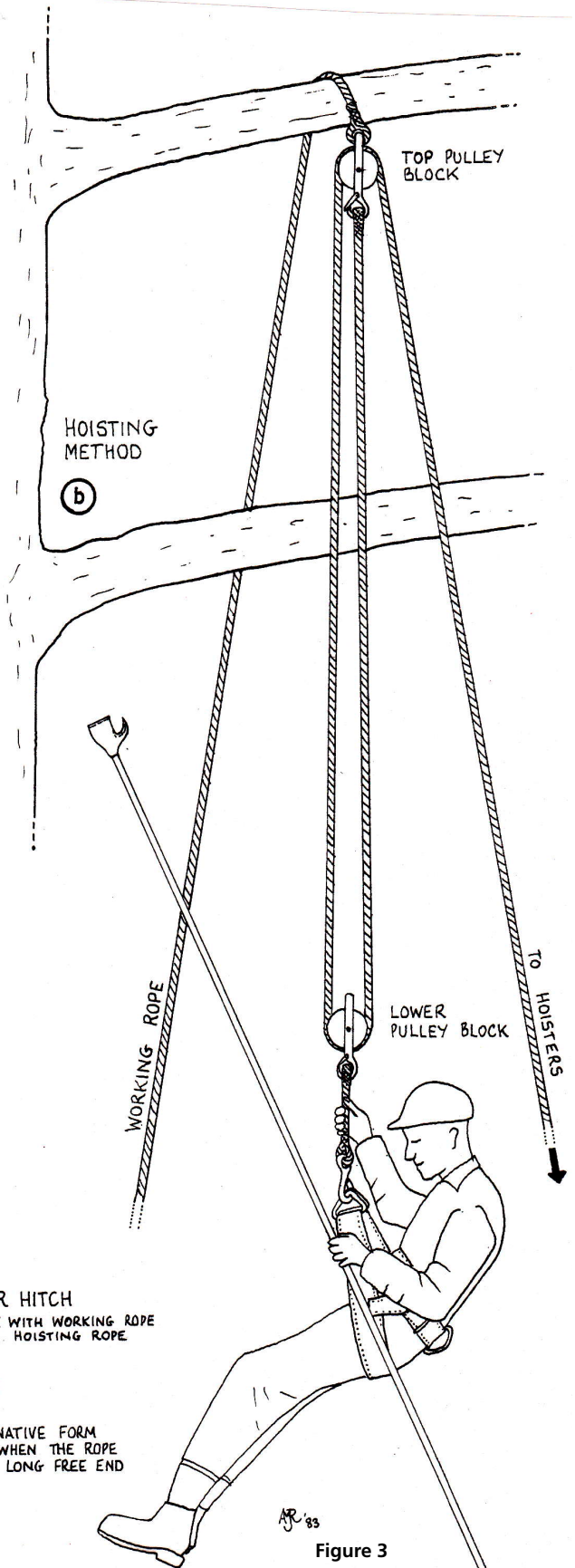


Figure 3

5. GAINING ACCESS BY HOIST

Choice of branch. When using a hoist, a branch should be chosen that gives the worker best access to the crown, but at the same time being strong enough to bear his weight safely. If the worker wishes to climb freely in the crown, then the working rope must be placed in a suitable position above climbable branches so that he can detach himself from the hoist. Often, as in the case of tropical hardwoods, the crown will be so wide spreading that the worker must remain suspended from the hoist. The branch must be tested by two men hanging on the working rope. If they are in any doubt as to the strength of the branch, then the working rope can be positioned so as to pass over several branches, in case one fails. An example is given in Fig. 3a. Attention should be given to the angle of pull of the rope on the branch as this can effect its load-bearing capacity.

Type of hoist. The most useful hoist consists of two single pulley blocks giving a purchase of 2:1 (Fig.3b). The pulley rope must be at least three times the length of the working rope. A suitable type is 13 mm diam. nylon, similar to the working rope. The pulley blocks should be as light as possible for ease of transport, with pulleys of 75 - 100 mm diam. and provided with an eye at the top of the block and a hook with safety catch at the bottom. For practical and safety reasons, two persons should be available to hoist the worker, although one person could do this. If a power winch is available on a vehicle, then this can be used, in which case it may be possible to use one pulley block or even the working rope itself without a pulley to hoist the worker.

Saddle. The standard tree-climber's harness which includes a saddle is suitable for use with the hoist. If the worker is to remain in the harness and requires both hands free to operate a tool, then extra support around his chest may be advisable to prevent him leaning back too far and overbalancing. A complete body harness may be better for difficult working positions. The lower pulley block can be attached directly to the harness saddle, but it is better to have a short length of rope between the pulley block and harness so that the block is about head height. This gives the worker a fixed rope to hold, and reduces the danger of getting the fingers pinched in the pulley.

Hoisting and tying off. Once the working rope has been used to position the hoist, it must be tied securely either to another tree, or a stake, or to the bole of the tree which is being climbed. In the latter case, this must be done carefully to avoid the rope slipping up the trunk - a suitable knot is shown in Fig. 3d. Test this knot with two men hanging on the hoist. Make sure that the top pulley is free and, before using the hoist, untwist the pulley rope so that the two strands are parallel. When the worker is securely fixed to the lower pulley block, he can be hoisted steadying himself by using his feet braced against the tree bole. If this is not possible, the worker may find himself gyrating and causing the pulley rope to twist on itself. A long handled cutter can be used to stop this if used as a brace against the bole. Once the worker has reached the crown, the pulley rope should be tied off in a similar fashion to the working rope. If both are tied off onto the bole, be careful not to confuse the two.

General safety. All rope connections with the pulley blocks must be secured with a safety catch if appropriate, so that during positioning of the upper pulley block and hoisting the ropes cannot snag and become detached. Although one person can lift another on a 2:1 purchase hoist, it is not advisable, since the hoister could slip, tire, etc. and lose his grip on the rope. If two persons hoist, then the likelihood of this happening is eliminated provided hauling is properly coordinated. As a further safety precaution, a mountaineering ascender can be attached to the pulley rope just beyond the hoisters, and tied off in the same way as the working rope; this will allow the pulley rope to pass freely through during ascent, but will act as a brake should the hoisters lose control (Fig. 3c).

Speed of operation. With experience the whole procedure of placing the working rope and block and tackle can be quite fast. Various techniques can be used to save time. Several advanced lines and storage drums catapult, so that the operator can quickly place advanced lines in several trees, whilst assistants complete position of the working rope. If a tree is to be climbed repeatedly, the 4 mm intermediate cord can be left in the crown and tied off onto a suitable branch for further use, thus avoiding repeated shooting of the advanced line (Strickland and Peters, 1961). If the worker is able to detach himself from the hoist and climb within the crown unaided, then he can use a personal safety rope with which to descend directly by abseiling, thus leaving the hoist free for positioning in another tree to be used by another worker.

6. CONCLUSION

Provided that the right equipment is available, it will be apparent that the advanced line technique can be a practical, safe, and versatile method for use in seed collection and other forestry and arboricultural operations. The reason that it is not used more widely is due to the lack of a suitable projection device which can be bought or easily made, but this should not deter foresters or others from trying out the method.

The different designs of devices described in the literature can be tried. Probably the most suitable for home construction is the Honduran catapult, and if required, full plans, constructional and operational details can be obtained from the author or from the Danida Forest seed centre.

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